The tide is high, but it's holding on: response of the grey bush-cricket, *Platycleis albopunctata*, to a storm surge

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Abstract

Coastal insects may be highly susceptible to population loss due to catastrophic inundation events. At two locations on the east coast of the UK (nature reserve and naturists' beach), the response of the Nationally Scarce grey bush-cricket, *Platycleis albopunctata*, to the December 2013 storm surge was determined from long-term transect monitoring of stridulating males. In the post-surge seasons, males were more frequent on the back dunes, which would have been largely unsubmerged during the tidal event. Lower numbers of *P. albopunctata* were recorded on the fore dunes after 2013, probably due to submergence during the surge tide and extensive shingle deposition on its marram-grass, *Ammophila arenaria*, and open ground habitats smothering overwintering eggs. The heterogeneity of the dune habitat with slacks and ridges may render this species resilient to storm surges.

Keywords

climate, coast, conservation, Orthoptera, sand dune, shingle, Tettigoniidae

Introduction

In December 2013 the UK was hit by the largest storm surge in 60 years, with the severe storm 'Hercules' causing further damage to coastal areas in January 2014 (Spencer et al. 2015). The storm (Xavier) which hit the UK on the 5th and 6th December 2013 resulted in the most serious tidal surge since the disastrous floods of 1953 (Environment Agency 2014). Record sea levels were observed in several locations due to the combination of low pressure interacting with the high tide (Spencer et al. 2015). Fortunately, in eastern England, a largely offshore, westerly wind meant that aggressive wave action on flood defenses was avoided. Where the storm surge of 1953 left 307 dead and 25000 properties flooded on the east coast of England, no flood-related deaths occurred during the 2013 surge, and 1400 properties were inundated (Environment Agency 2014). The improvements to sea wall flood defenses since the 1950s and improved flood warnings (none were issued in 1953) went a long way to ensure that there was no repeat of the devastating 1953 surge.

What is not documented is how coastal invertebrates may be affected by storm surges. The response of the scaly cricket *Pseudomogoplistes vicentae* (IUCN Red Data List - Vulnerable) in the UK to storm surges in 2013/2014 has been studied by Professor Karim Vahed and reported in Sutton et al. (2017). The shingle habitat had been removed at several sites containing this cricket, which may have led to a contraction in populations. Interestingly, *P. vicentae* lays its eggs in driftwood so may be able to recolonize sites after storm damage (Sutton et al. 2017). In Essex, south-east England, there were lower numbers of the mottled grasshopper *Myrmeleotettix maculatus* (included in the Essex Red Data List) after the 2013 storm surge at a reintroduction site on sand dunes (Gardiner and Seago 2015, Gardiner et al. 2017).

The grey bush-cricket, *Platycleis albopunctata*, is a Nationally Scarce coastal species in the UK (Sutton et al. 2017). The insect is a thermophile (Ingrisch and Köhler 1998) with an annual life cycle (Ingrisch 1986). Adults feed on bugs and flies as well as grass-seeds and herbaceous plants (Hein 2004). In many situations in Europe, the preferred locations have plenty of sparse, open ground in dry grassland due to egg-laying in the soil or in dry plant stems (Hein 2004). Its thermophilic nature also dictates its habitat, sparse grassland with bare ground being warmer than taller vegetation (Hein 2004). On the east coast of the UK, *P. albopunctata* is localized and inhabits sand dune and shingle habitats to the north of the Thames Estuary (Gardiner and Seago 2015). These isolated populations at the north of its UK range contain an abundance of exposed soil in sparse grassland susceptible to tidal inundation during storm surges.

Its northern most sites on the east coast of the UK are in the county of Suffolk: on vegetated shingle at Orford Ness and Shingle Street (Ling 2000), saline lagoon edges (Telfer 2013), and in grassland abutting sea walls at Iken (Abrehart 2015) and Havergate Island. Unfortunately, the 2013 storm surge led to widespread flooding of *P. albopunctata* habitat on Havergate Island in particular, which may have proved deleterious to the species. In Essex, ca. 35 km to the south of Shingle Street, *P. albopunctata* is reliably found at only two sites: Colne Point and St. Osyth naturists' beach. This short communication details the response of *P. albopunctata* to the December 2013 surge impact at its only locations on the Essex coast.

Methods

Transect survey.—*Platycleis albopunctata* (Orthoptera: Tettigoniidae) was rediscovered in pitfall traps at Colne Point (Essex, UK) in 2004, after an absence of records for over 50 years (Harvey et al. 2006, Harvey and Gardiner 2006). Previous searches for *P. albopunctata* at Colne Point may have been unsuccessful due to the extremely localized distribution of the species at the site (Harvey and Gardiner 2006) and the tendency of population size to fluctuate largely between years (Gottschalk et al. 2003), which may have led to this species being overlooked by *ad hoc* visual surveys in years with small populations. The ineffectiveness of visual searching may also be compounded by the greyish brown color of *P. albopunctata* adults, which provides effective camouflage in tall and dense stands of marram-grass, *Ammophila arenaria*, where the proportion of green vegetation is low. Recent research suggests that pitfall traps can be very effective at sampling the Orthoptera of sand dunes (Schirmel et al. 2009). However, pitfall traps did not appear to be especially effective for sampling *P. albopunctata* in sand dunes (no significant difference between numbers in pitfall traps and transect counts), despite their efficacy for monitoring ground-active orthopterans such as *M. maculatus* (Schirmel et al. 2009).

A fixed route transect (4.8 km long) was established in 2010 at Colne Point to monitor the only reliable sites for the species in the county (Gardiner et al. 2010). The transect was walked at a slow strolling pace (2 km/h) and all stridulating adult male *P. albopunctata* (Samways 1976), located using a bat detector (Magenta III) set at 28 kHz, were recorded. The transect was subdivided into different sections (a map of the transect sections is kept by all authors and Essex Wildlife Trust (EWT)), two of these being on the fore dunes of Colne Point nature reserve and St. Osyth naturists' beach (<10 m from strandline, 3.5–4 m Above Ordnance Datum (AOD) defined as height relative to the average sea level at Newlyn, Cornwall, UK) and two on the back dunes of the same two sites (>10 m from strandline to approximately 10 m from salt marsh edge, 4–4.6 m AOD).

The December 2013 surge was observed to have affected the spit at its eastern end (on the naturists' beach fore dunes in particular but also on the Colne Point nature reserve) where shingle had been moved and deposited on the fore dunes smothering large areas of *A. arenaria* (Fig. 1), a potentially important habitat for *P. albopunctata*. There was also some deposition on the back dunes (Fig. 2).

The transect encompassed the main sand dunes on the Colne Point nature reserve running from 51°46'18.5"N, 1°02'23.0"E to 51°46'13.0"N, 1°03'42.6"E (south of the creek) and also the dunes on the naturists' beach from 51°46'13.0"N, 1°03'42.6"E to 51°46'16.4"N, 1°04'17.0"E. Because the transect route involved walking the same length of fore (1600 m Colne Point, 800 m for naturists' beach) and back dune (1600 m for Colne Point, 800 m for naturists' beach), the numbers detected in these two areas were directly comparable and represented areas potentially affected by the surge tide.

Post-surge shingle analysis.—The percentage ground cover of *A. arenaria* and shingle substrate were estimated in 10 randomly positioned 50 × 50 cm frame quadrats (0.25 m^2) on the fore dunes and in another 10 quadrats on the back dunes of both Colne Point nature reserve and the naturists' beach. In total 40 quadrats were surveyed, 20 for each site, in September 2015.

Statistical analysis.—For ease of analysis, the annual bat detector counts of *P. albopunctata* in August on the fore and back dunes of both the naturists' beach and Colne Point nature reserve can be totalled into pre-surge (2011–13; three annual surveys) and post-surge (2014–16; three annual surveys) years. All data were square root transformed before analysis to correct for non-normality (Heath 1995). To determine whether *P. albopunctata* differed between the two sites, a Student's t-test was used to compare the mean number of bush-crickets per transect section (2 per site) pre-surge and post-surge.

To ascertain whether there was a preference for the back or fore dunes, the mean stridulation count per site for the back and fore dunes was compared using a Student's t-test for both the pre-surge and post-surge periods. The mean percentage cover per quadrat of shingle and *A. arenaria* for the back and fore dunes were compared using a Student's t-test (Heath 1995).

Fig. 1. Shingle deposition on the fore dunes. Photo credit Tim Gardiner.

Fig. 2. Shingle deposition on the back dunes. Photo credit Tim Gardiner.

Results

Stridulation counts did not differ significantly between the Colne Point nature reserve and naturists' beach either pre-surge ($t = -1.78$) or post-surge ($t = -0.63$) (Fig. 3). There was also no significant difference between the stridulation counts on fore and

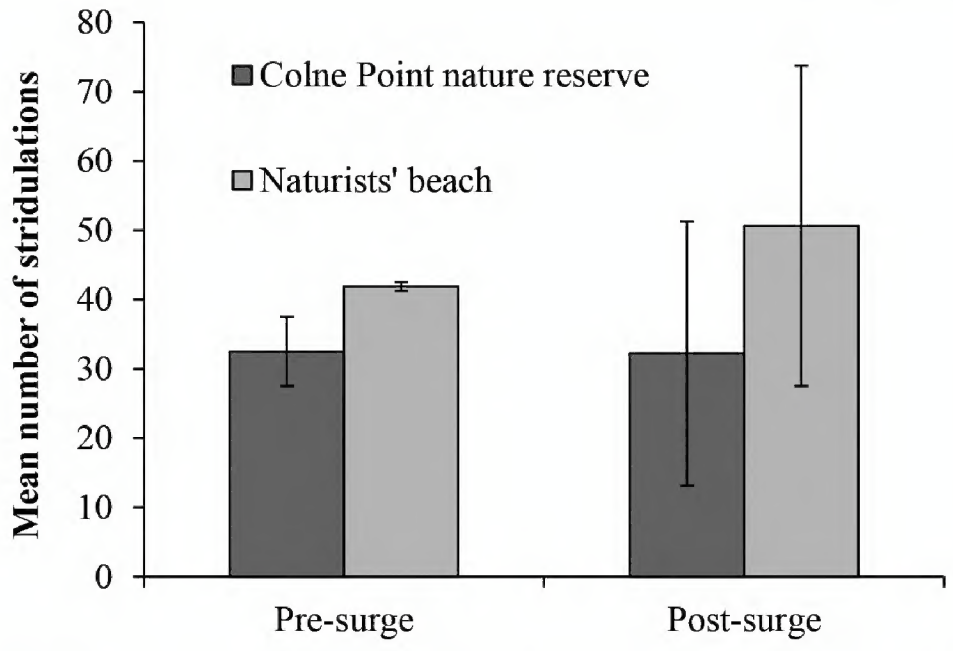

Fig. 3. The mean number of stridulating males recorded on the Colne Point nature reserve and St. Osyth naturists' beach pre- and post-surge.

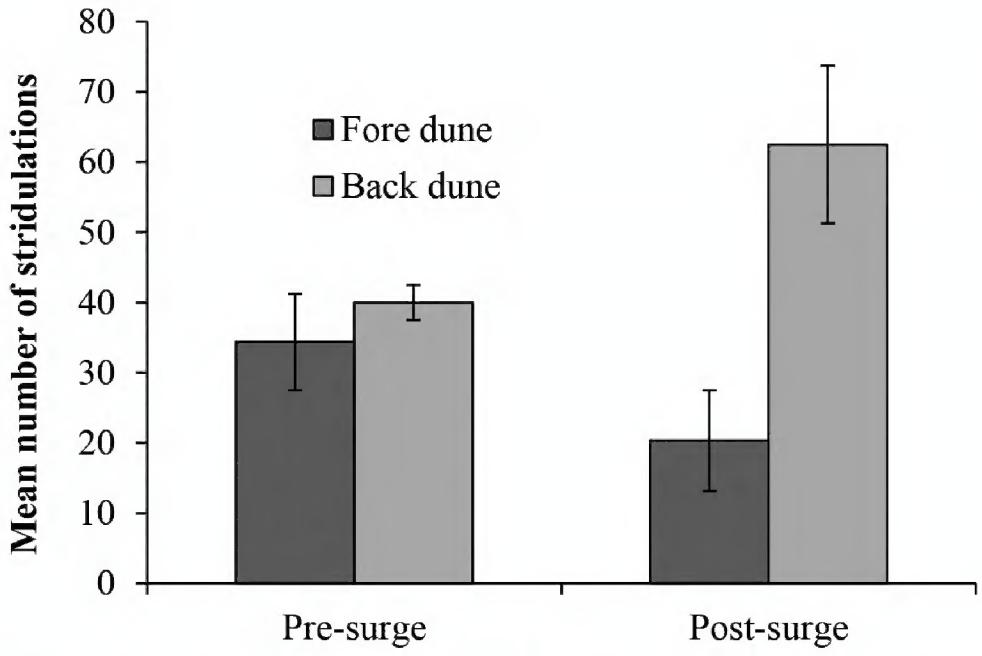

Fig. 4. The mean number of stridulating males recorded on the fore and back dunes pre- and post-surge.

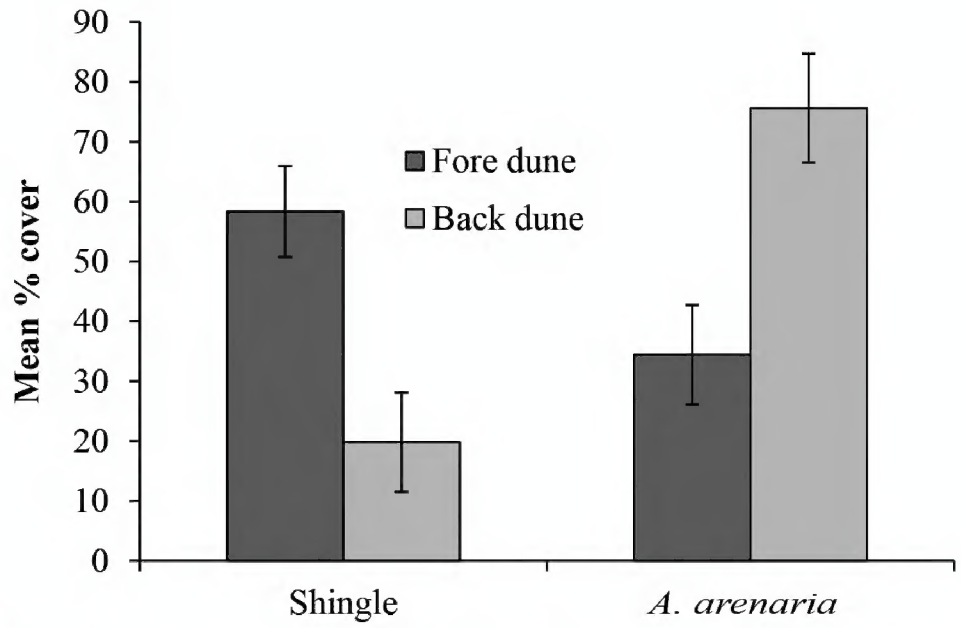

Fig. 5. Mean ground cover of shingle and *Ammophila arenaria* on the fore and back dunes post-surge.

back dunes pre-surge (t = 0.79). However, post-surge, stridulating males were much more frequent on the back than the fore dunes (t = 3.19, p = 0.04) (Fig. 4).

The mean cover of *A. arenaria* on the fore dunes was significantly lower (t = -2.62, df, p = 0.01) than on the back dunes in total contrast to the cover of shingle which was higher (t = 4.23, p<0.0001) on the fore dunes post-surge (Fig. 5).

Discussion

Given the requirement for 30000 adults for a bush-cricket population to be viable in heterogeneous environments without optimal surrounding habitat (Griebeler and Gottschalk 2000), highly isolated populations of *P. albopunctata* such as at Colne Point (nearest site at Shingle Street >35 km to north) may be extremely susceptible to extirpation due to catastrophic storm surge events. Once lost from Colne Point and the naturists' beach, its sole populations in the county of Essex, recolonization is extremely unlikely due to the surrounding sub-optimal habitats for this species (arable land and salt marsh).

The December 2013 storm surge levels (AOD) for the nearby Strood (mean 3.88 m, min/max 3.72–3.95 m) (Spencer et al. 2015) suggest that the back dunes will have been above the high water level (>4 m AOD) but not the fore dunes (<4 m AOD). The submergence of the fore dunes may have caused the mortality of *P. albopunctata* eggs laid in the grass, whereas those in the back dunes were probably unharmed, although wave splash may have led to localized inundation. Population abundance of *P. albopunctata* can vary by a factor of 10 between years (Gottschalk et al. 2003), so depending on the severity of the event, it's possible that the species may be dramatically reduced at its outlying coastal sites north of the Thames. On the fore dunes, abundance was reduced by 41% post-surge, while a 57.5% increase was noted on the back dunes (Fig. 4). This indicates that the storm surge did not have the directly devastating impact on the species we envisaged from submergence of its egg habitat. Of greater consequence appeared to be the alteration of dune habitat.

The generally poor growth of *A. arenaria* on the fore dunes of the naturists' beach in particular and significant shingle cover post-surge suggests a poorer environment for *P. albopunctata* due to the sparseness of grass cover and fringe habitat for stridulating males (Hein 2004). It appears that the species may have been affected by the smothering and die-back of its preferred *A. arenaria* tussock and bare sand habitat on the fore dunes and may have dispersed to the relatively unaffected back dunes which maintained fairly dense (>50% cover) *A. arenaria* growth post-surge, while still maintaining the required open ground for basking and oviposition.

The recovery of populations post-surge will have been influenced by the movements of individuals which hatched from eggs that survived the event. The dispersal of *P. albopunctata* (individuals can move 50–350 m) may be determined not only by suitable breeding habitat but by food resources and habitat-specific mortality risk (Hein et al. 2003). Therefore, the matrix of fore and back dunes should allow species to survive the worst effects of a storm surge, providing there is habitat which is not affected by movement of shingle or inundation. Given the speed with which *P. albopunctata* recolonized a fire site at Colne Point (individuals seen on burned ground just 10 months after the fire; Seago and Gardiner 2017), recolonization of the fore dunes may be fairly rapid. Studies on the resilience of other coastal Orthoptera (e.g., *P. vicentae*, Sutton et al. 2017) suggests adaptations to this changing and unstable environment.

Fortunately, *P. albopunctata* appears to be spreading at Colne Point, which may increase its resilience to further storm surges. New sightings of the insect since 2013 on the western spit, seaward slope of the sea wall embankment, and Jetty Ridge, suggest an expanding population. Colonization of the sea wall followed Environment Agency cutting of the seaward face over winter 2013/14 after a single male was heard in 2011 (Gardiner et al. 2015). It is believed that the cutting back of scrub and rank grass on the infrequently mown seaward slope created the patchy sward with

exposed soil and tall fringe vegetation which the bush-cricket seems to require (Hein 2004). Breeding populations on the sea wall slopes will shelter the bush-cricket from the worst effects of future storm surges and allow it to spread along the flood defense corridor towards Jaywick to the east and Point Clear to the north.

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